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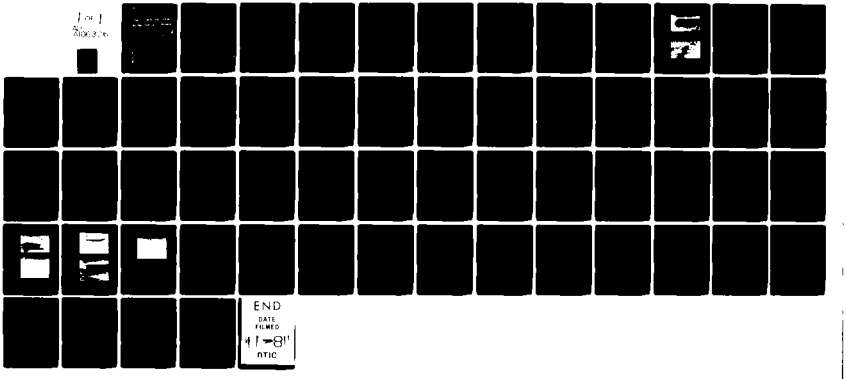

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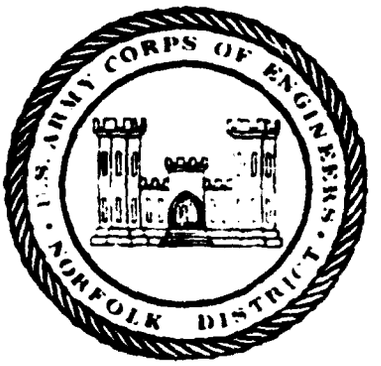
JAMES RIVER BASIN

Name Of Dam: DOVER LAKE DAM

Location: GOOCHLAND COUNTY, VIRGINIA

Inventory Number: VA. NO. 07503

PHASE I INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM



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JULY 1981

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20. Abstract

Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I Inspection is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general conditions of the dam is based upon available data and visual inspection. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam appurtenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

JAMES RIVER BASIN

NAME OF DAM: DOVER LAKE DAM
LOCATION: GOOCHLAND COUNTY, VIRGINIA
INVENTORY NUMBER: VA. NO. 07503

National Dam Safety Program. Dover Lake Dam (Inventory Number VA 07503), James River Basin, Goochland County, Virginia. Phase I Inspection Report.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Ray E. /Martin Carl S. /Anderson, Jr.
Jack G. /Starr

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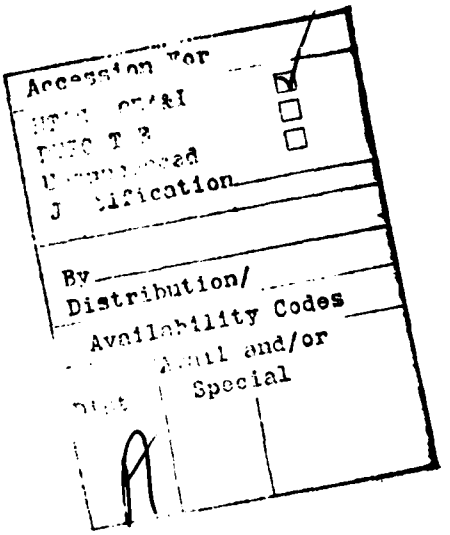

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

BRIEF ASSESSMENT OF DAM

Name of Dam:	Dover Lake Dam
State:	Virginia
Location:	Goochland County
USGS Quad Sheet:	Midlothian & Hylas
Coordinates:	Lat 37° 37.0' Long 77° 44.8'
Stream:	Dover Creek
Date of InspectionP	April 21, 1981

Dover Lake Dam is a homogeneous earthfill structure about 530 ft long and 36 ft high. The principal spillway consists of twin 48 inch diameter concrete riser pipes and a 48 inch diameter pipe which extends through the structure. Earth emergency spillways are located at the right abutment with 75 ft wide bottom and 2H:1V side slopes, and at the left abutment with a 36 ft wide bottom and 2H:1V side slopes. The structure is classified small in size and is assigned a significant hazard classification. The dam is located on Dover Creek immediately north of Sabot, Virginia. The lake is used for irrigation and recreational purposes, and is owned and maintained by Sabot Hill Farm, Inc.

Based on criteria established by the Department of the Army, Office of the Chief of Engineers (OCE), the appropriate Spillway Design Flood (SDF) is the ½ PMF. The spillways will pass 30 percent of the Probable Maximum Flood (PMF) or 60 percent of the SDF without overtopping the dam. During the SDF, the dam will be overtopped by a maximum of 1.3 ft for a period of 4 hours at a maximum velocity of 4.9 fps. The spillway is judged inadequate, but not seriously inadequate.

The visual inspection revealed no apparent problems. An evaluation of the stability condition could not be made since there is insufficient design and construction data for this structure. The downstream embankment slope and crest meet U. S. Bureau of Reclamation requirements, however, the upstream slope is slightly steeper than recommended for the rapid drawdown condition. Based on the design and construction of the dam and the performance history of the structure this is not considered a serious problem therefore, a stability check is not required. Flows overtopping the dam during the SDF are not considered detrimental to the embankment with respect to erosion.

It is recommended that the owner implement an emergency action plan measure to warn the downstream dwelling of any dangers which may be imminent.

The following routine maintenance and observation functions should be initiated within the next twelve months;

The grass and weeds on the dam embankment and in the emergency spillways should be cut at least once a year and preferably twice a year. Maintenance is recommended in the early summer and fall. Existing trees on the dam should be cut to the ground. Trees greater than 3 inches in diameter should have their stumps and root structures removed and resulting holes backfilled.

The upstream slope and plunge pool area should be protected against further erosion by lining with riprap. The eroded area observed in the discharge section of the right emergency spillway should be backfilled and reseeded. Animal burrows in the embankment should be backfilled.

Seepage present below the discharge pipe should be monitored quarterly to detect any increase in flow rates which may cause piping within the embankment. A staff gage should be installed to monitor water levels.

Prepared by:

SCHNABEL ENGINEERING ASSOCIATES, P.C./
J. K. TIMMONS & ASSOCIATES, INC.

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District Engineer

Recommended by:

Original signed by
JACK G. STARR

Jack G. Starr, P.E.
Chief, Engineering Division

Date: AUG 6 1981

Dover Lake

Dam

Overview Photographs

SECTION 1 - PROJECT INFORMATION

1.1 General:

1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of safety inspection of dams throughout the United States. The Norfolk District has been assigned the responsibility of supervising the inspection of dams in the Commonwealth of Virginia.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (see Reference 1, Appendix IV). The main responsibility is to expeditiously identify those dams which may be a potential hazard to human life or property.

1.2 Project Description:

1.2.1 Dam and Appurtenances: Dover Lake Dam is a homogeneous earthfill structure approximately 530 ft long and 36 ft high.* The crest of the dam is 18 ft wide, and side slopes are approximately 2.5 horizontal to 1 vertical (2.5H:1V) on the upstream and downstream slopes of the dam. A 10 ft wide berm occurs between elevation 160 and 159 msl on the upstream slope. The crest of the dam is at elevation 171 msl. Design drawings indicate the embankment includes a core trench which extends to "solid rock" (Plate 4, Appendix I). No internal drainage system was provided in design. There is no slope protection.

* Height is measured from the top of the dam to the downstream toe at the centerline of the stream.

The principal spillway consists of a twin 48 inch diameter reinforced concrete pipe riser inlet. The riser is connected to a 48 inch diameter reinforced concrete outlet pipe which runs through the dam. The riser crest is at elevation 160 msl. A 24 inch diameter slide gate in the riser at an invert elevation of 137 msl is used to drain the lake. The 48 inch outlet pipe is 134 ft long with an invert elevation at the outlet structure of 136 msl. (See Plate 2, Appendix I).

The emergency spillways consist of two vegetated earthen channel spillways located on the right and left abutments, each having a crest elevation of 165 msl. The right spillway has a bottom width of 75 ft, 2H:1V side slopes, and is partially in a cut section. The left spillway has a bottom width of 36 ft, 2H:1V side slopes, and is entirely located in a cut section. (See Plate 2, Appendix I).

1.2.2 Location: Dover Lake Dam is located on Dover Creek immediately north of Sabot, Virginia (See Plate No. 1, Appendix I).

1.2.3 Size Classification: The dam is classified as a small size structure based on its height and maximum lake storage potential.

1.2.4 Hazard Classification: The dam is located in a rural area; however, based upon the proximity of one inhabited dwelling located ¼ mile downstream, the dam is assigned a "significant" hazard classification. The hazard classification used to categorize a dam is a function of location only and has nothing to do with its stability or probability of failure.

1.2.5 Ownership: The dam is owned and maintained by Sabot Hill Farm, Inc., Sabot, Virginia.

1.2.6 Purpose: Recreation and irrigation.

1.2.7 Design and Construction History: The dam was designed and constructed under the supervision of the United State Department of Agriculture (USDA), Soil Conservation Services (SCS). The dam was constructed by Moore, Reddish and Kelly of Orange, Virginia and completed in 1958. The emergency spillways were enlarged in 1980.

1.2.8 Normal Operational Procedures: The principal spillway is ungated, therefore, water rising above the crest of the riser outlet is automatically discharged downstream. Normal pool is maintained at elevation 160 msl at the crest of the riser. Flood discharges which cannot be absorbed by storage and the riser, flow through the emergency spillways at pool elevations above 165 msl. The 24 inch diameter gate at elevation 137 msl is a manually operated valve and is to be used to lower the lake elevation below normal pool.
We understand this gate has never been opened since construction of the dam.

1.3 Pertinent Data:

1.3.1 Drainage Area: The drainage area is 7.63 square miles.

1.3.2 Discharge at Dam Site: According to Mr. Reed, and a measured high water mark, the maximum known flood at the dam site occurred in October 1979 when an estimated pool elevation of 167.7 msl was observed. This corresponds to an approximate discharge of 2694 CFS. Moderate erosion occurred in both emergency spillways.
Principal Spillway Discharge:

Pool Elevation at Crest of Dam (elev 171)	333 CFS

Emergency Spillway Discharge

Pool Elevation at Crest of Dam (elev 171)	5190 CFS

1.3.3 Dam and Reservoir Data: See Table 1.1, below:

Table 1.1 - DAM AND RESERVOIR DATA

	Reservoir				
		Storage			
	Elevation feet msl	Area Acres	Volume Acre Feet	Watershed Inches	Length Miles
Crest of Dam	171	173	1631	4.01	1.8
Emergency Spillway Crest	165	107.5	908	2.23	1.4
Principal Spillway Crest	160	52	396	.97	.75
Streambed at Downstream Toe of Dam	135	-	-		-

2.1 [illegible]: The [illegible] and [illegible] under the [illegible], Soil [illegible] (SCS). [illegible] [illegible], Virginia.

A [illegible] investigation consisting of 10 auger probes was conducted at the site by SCS personnel during the design phase of the project. Boring locations and a legend of the [illegible] are presented on Plate 4 of Appendix I. The purpose of the investigation was to determine the subsurface soil and rock conditions for the dam and the emergency spillways.

The dam was designed as a homogeneous, compacted earth fill embankment with side slopes of 2.5H:1V. A 10 ft wide berm was planned on the upstream slope between elevations 159 and 160 msl. A core trench was provided in design, extending [illegible] Stations 1+25 and 6+00. A bottom width of 15 ft and side slopes of 1H:1V were planned and the maximum depth of excavation, 9 ft, was proposed at Station 4+60. Design details are presented on Plates 4 and 5, Appendix I.

The principal spillway was designed as a drop inlet structure consisting of a reinforced concrete riser, a transition section at the base of the riser, a 48 inch conduit and a stilling basin or plunge pool at the outlet end of the conduit. The reinforced concrete riser was not constructed according to plans and was replaced with two 48 inch diameter reinforced concrete riser pipes.

One reinforced concrete anti-seep collar was installed around the principal spillway pipe, upstream of the core trench in order to control any potential piping problems along the spillway pipe. Details of the principal spillway and riser are shown on Field Sketch No. 2 of Appendix III and Plate 3, Appendix I. No internal drainage system was provided for this structure.

The emergency spillways are designed as trapezoidal vegetated earth channels cut into natural ground.

2.2 Construction: The dam was constructed by Moore, Reddish & Kelly of Orange, Virginia and completed in 1958. There were no construction records available for the structure. According to Mr. Joseph Scales (SCS) the embankment was constructed with soils excavated from the reservoir, spillways and hilltop bounding the right emergency spillway. He described the fill material as consisting of 60 - 65% sand, 20 - 25% silty clay and the remainder as silt. The fill was placed in 8 to 12 inch lifts and compacted with a sheepsfoot roller. The owner and his personnel reportedly observed the fill placement. Although no field density tests were taken, construction was inspected periodically by SCS personnel. Initial construction of the emergency spillways was only one-half the plan size. As a result of insufficient spillway capacities and consequential erosion, both spillways were widened in 1980 to conform to plan requirements.

2.3 Evaluation: Except for the spillway riser, the design drawings are generally representative of the structure. Field measurements indicate that the embankment crest is 2 ft wider and the embankment length is 85 ft shorter than shown on the design drawings. Hydrologic and hydraulic calculations were not available for evaluation. There is sufficient information to evaluate foundation conditions but not the embankment stability.

SECTION 3 - VISUAL INSPECTION

3.1 Findings: At the time of inspection, the dam appeared to be in good condition. Field observations are outlined in Appendix III.

3.1.1 General: An inspection was made on April 21, 1981 and the weather was clear with a temperature of 55° F. The pool and tailwater levels at the time of inspection were 160.0 and 135.3 msl, respectively, which corresponds to normal pool and tailwater elevations. Ground conditions were damp at the time of the inspection. No previous inspection reports were available.

3.1.2 Dam and Spillway: The embankment slopes were heavily vegetated with honeysuckle and briars making observation difficult. Scattered small trees ranging from ½" to 2"± in diamter were also present. A continuous series of such trees occur at pool level along the entire upstream slope.

No sloughing or erosion was noted on the downstream slope; however, numerous erosional notches occur between the trees along the entire upstream slope at pool level. These notches extend approximately 3 ft into the embankment and range from 1 to 10 ft in width. Several groundhog holes were observed along the bottom 10 ft of the downstream slope, approximately 90 ft from the left abutment. Some erosion or washing consisting of a flow path 1 to 2 ft deep and 1 ft wide was noted in the discharge section of the right emergency spillway. Some erosion was also noted on the right spillway side slope.

The only seepage encountered was in the vicinity of the discharge pipe. (See Field Sketch, Sheet 1, Appendix III). Iron stained seepage was observed flowing at an estimated 2-3 gpm from the base of a rock pile 12 to 14 ft downstream of the right end of pipe. No turbidity was noted. Iron staining was also encountered two locations below the left side of the pipe, 5 ft$\pm$ and 50 ft$\pm$ beyond the end of the pipe. No flow was observed at either location. The toe of the downstream slope was dry.

The riser structure and outlet pipe showed no signs of deterioration and were functioning properly at the time of inspection. The slide gate has not been operated since it was installed. The plunge pool was void of riprap and indicated some erosion. The 8 ft wide berm shown on the design drawings on the upstream slope was submerged.

3.1.3 Reservoir Area: The reservoir area was free of debris and the perimeter was wooded. The reservoir is located in a valley with side slopes at approximately 4H:1V. Some sediment buildup was reported in the upper reaches of the lake indicating a 2-3 ft change in water depth in recent years.

3.1.4 Downstream Area: The downstream channel consists of an 8 ft wide channel located in a valley with steep side slopes (10H:1V to 20H:1V). This valley is heavily wooded on the right side and cultivated on the left side. Approximately ¼ mile downstream there is a dwelling owned and rented out by Mr. Reed about 12 ft above the streambed. A restriction in the stream exists immediately below the dwelling.

3.1.5 Instrumentation: No instrumentation (monuments, observation wells, piezometers, etc.) was encountered for the structure. There is no staff gage. High water experienced during flooding in 1979 was indicated by a mark inside the dwelling on the lake.

3.2 Evaluation:

3.2.1 Dam and Spillway: Overall, the dam was in good condition at the time of the inspection. It is recommended that a routine maintenace program be initiated. The embankment, including its crest and slopes should be mowed at least once a year, but more preferably twice a year. The presence of trees on the embankment, particularly those at pool level on the upstream slope, may promote the development of deep rooted vegetation and this type growth can encourage piping within an embankment. All trees growing on the embankment should be cut to the ground.

Considerable erosion was noted on the embankment along the upstream slope due to wave activity. It is recommended this erosion be corrected and that riprap be placed along the upstream slope to provide embankment protection. Riprap should also be placed in the plunge pool to prevent erosion. The groundhog holes do not presently create an unsafe condition; however, future borrowing could result in numerous voids in the embankment which could be potentially hazardous under certain conditions. It is recommended that existing burrows be backfilled. The eroded area observed in the discharge section of the right emergency spillway should be backfilled and reseeded. Erosion noted on the right side slope does not require any special attention.

The seepage and iron staining observed downstream of the discharge pipe are believed to be related to seepage through the dam, but could possibly be related to spring activity. These areas do not present a hindrance to the normal functioning of the dam, however, it is recommended they be monitored quarterly to detect any increase in flow rates which may cause piping in the embankment. If increased flows should occur, a Professional Engineer with expertise in Geotechnical Engineering should be contacted to evaluate the problem and make recommendations for required corrective measures.

The outlet pipe and intake structure are in good structural condition. The operating appurtenances are reported to be functionally good. A staff gage should be installed to monitor water levels.

3.2.2 Downstream Area: A breach in the Dover Lake Dam during extreme flooding would possibly create a hazard to the downstream dwelling.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures: The normal storage pool is elevation 160.1 msl or 0.1 ft above the crest of the concrete principal spillway inlet. The lake provides an irrigation supply and recreation. Water automatically passes through the principal spillway as the water level in the reservoir rises above the principal spillway crest. Water will also pass automatically through the emergency spillways when the water level in the reservoir reaches elevation 165. A 24 inch slide gate valve at the low point in the riser structure is provided to drawdown the reservoir below normal pool.

4.2 Maintenance of Dam and Appurtenances: Maintenance is the responsibility of the owner. Maintenance consists of inspection, debris removal, mowing of vegetative cover and repair. Maintenance is performed, but not routinely.

4.3 Warning System: At the present time, there is no warning system or evacuation plan for the dam.

4.4 Evaluation: The dam and appurtenances are in good operating condition, and maintenance of the dam appeared to be adequate. A routine maintenace program including documentation should be developed for this structure. An emergency operation and warning plan should be developed. It is recommended that a formal emergency procedure be prepared and furnished to all operating personnel. This should include:

a. How to operate the dam during an emergency.

b. Who to notify, including public officials, in case evacuation from the downstream area is necessary.

SECTION 5 - HYDRAULICS/HYDROLOGIC DATA

5.1 Design: Dover Lake Dam was designed by the Soil Conservation Service (SCS) as a multi-purpose dam; however, hydrologic and hydraulic data are not available. This structure is a Class "A" dam according to the SCS classification method.

5.2 Hydrologic Records: There are no records available.

5.3 Flood Experience: According to Mr. Reed and a measured high water mark, an estimated maximum pool elevation of 167.7 msl occurred in October 1979. This corresponds to a peak flow of approximately 2694 CFS.

5.4 Flood Potentials: In accordance with the established guidelines, the Spillway Design Flood (SDF) is based on the estimated "Probable Maximum Flood" for the region (flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region), or fractions thereof. The Probable Maximum Flood (PMF) and ½ PMF and 100 year flood hydrographs were developed by the HEC-1 method (Reference 5, Appendix IV). Precipitation amounts for the flood hydrograph of the PMF and 100 year flood were taken from U. S. Weather Bureau Information (References 6 and 7, Appendix IV). Appropriate adjustments for basin size and shape were accounted for. These hydrographs were routed through the reservoir to determine maximum pool elevations.

5.5 Reservoir Regulations: For routing purposes, the pool at the beginning of flood was assumed to be at elevation 160 msl. Reservoir stage-storage data and stage-discharge data were computed from construction plan details and available topographic data. Floods were routed through the reservoir using the principal spillway discharge up to a pool storage elevation of 165 msl and a combined principal and emergency discharges for pool elevations above 165 msl. Pool elevations above 171 msl were routed over the non-overflow section of the dam.

5.6 Overtopping Potential: The predicted rise of the reservoir pool and other pertinent data were determined by routing the flood hydrographs through the reservoir as previously described. The results for the flood conditions (100 year flood, ½ PMF and PMF) are shown in the following Table 5.1:

TABLE 5.1 [illegible]

			Hydrograph	
	Normal Flow	100 Year Flood	½ PMF	PMF
Peak Flow, CFS				
Inflow	7.5	4694	12,658	25,317
Outflow	7.5	2701	11,833	24,358
Maximum Pool Elevation Ft, msl	160.1	169	172.3	174.7
Non-Overflow Section (Elev 171 msl)				
Depth of Flow, Ft	-	-	1.3	3.7
Duration, Hours	-	-	4	6
Velocity, fps	-	-	4.9	8.2
Tailwater Elevation Ft, msl	135.3	139.3	142.4	144.7

5.7 Reservoir Emptying Potential: A 24 inch diameter gate at elevation 137 msl is capable of draining the reservoir through the outlet pipe. Assuming that the lake is at normal pool elevation (160 msl) and there is 7 cfs inflow, it would take approximately 2.5 days to lower the reservoir to elevation 137 msl. This is equivalent to an approximate drawdown rate of 11 ft/day based on the hydraulic height measured from normal pool to the invert of the drawdown pipe divided by the time to dewater the reservoir.

5.8 Evaluation: The U. S. Army Corps of Engineers' criteria indicate the appropriate Spillway Design Flood (SDF) for a small size, significant hazard dam in the 100 year to 1/2 PMF. Because of the risk involved, the 1/2 PMF has been selected as the SDF. The spillway will pass 50 percent of the PMF without overtopping the crest of the dam (60 percent of the SDF). During the SDF, the dam will be overtopped by a maximum of 1.3 ft for a period of 4 hours at a maximum velocity of 4.9 fps.

Hydrologic data used in the evaluation pertains to present day conditions with no consideration given to future development.

SECTION 6 - DAM STABILITY

6.1 Foundation and Abutments: The dam is located along the eastern portion of the Piedmont physiographic province of Virginia. The site is underlain by residual soils derived from the in place weathering of the underlying granitic gneiss bedrock of Precambrian age. The gneiss is generally schistose, coarse-banded and well foliated. Test borings indicate the presence of a relatively thin residual soil cover. Bedrock was encountered at depths ranging from 2 to 18 ft along the centerline of the dam and emergency spillways. Geologic maps of the area indicate local strike of bedrock foliation is north to northeast and dips range from 30 to 60 degrees to the southwest. The closest fault mapped near the site is located approximately one mile southeast of the dam.

The potential for seepage within the foundation was apparently recognized by the designer, since design drawings indicate the presence of a cutoff trench. Design drawings show the embankment resting on natural soils with a cutoff trench extending down to or slightly into "solid rock". The bottom of the trench is 15 ft wide and has side slopes of 1H:1V. Trench depths are illustrated on Plates 4 and 5, Appendix I.

Gradual consolidation of underlying soils would be expected during application of fill materials. The underlying soils probably had essentially fully consolidated under the applied load not long after completion of construction. Based upon the performance history of this dam and the materials present, a stable foundation is assumed.

6.2 Embankment:

6.2.1 Materials: Design drawings show the dam as a homogeneous embankment. A specification for material quality was not included

with the design drawings, however according to SCS personnel the dam was constructed with a rather consistent soil blend consisting of 60 - 65% sand, 20 - 25% silty clay and the remainder silt. The fill was placed in 8 to 12 inch lifts and compacted with a sheepsfoot roller. Field density tests were not performed to verify the percent compaction however fill placement was observed essentially full time by farm personnel and periodic inspection visits were made by SCS personnel. The surface embankment soils appeared to consist of micaceous silty sands (SM) to clayey sands (SC) and fine micaceous sandy clayey silts (MH) to silty clays (CL). Local SCS data was reviewed (Reference 3, Appendix IV) in order to verify the type soils excavated from the borrow areas. The soils identified include the Pacolet clay loam, Madison fine sandy loam and Louisburg fine sandy loam. These soils have Unified Soil classifications within the range of those visually described during the inspection.

6.2.2 Subdrains and Seepage: A drainage system was not included in the design of this structure. Iron stained seepage was observed at one location 10 to 12 ft downstream of the discharge pipe on the downstream side of the dam. The flow was estimated at 2 to 3 gpm and no turbidity was noted.

6.2.3 Stability: A stability analysis was not performed for this structure; however, we understand the embankment slopes were designed in accordance with SCS guidelines. The dam is 36 ft high and has a crest width of 18 ft. Side slopes are approximately 2.5H:1V on the upstream and downstream slopes of the dam. A 10 ft wide berm occurs between elevation 160 and 159 msl on the upstream slope.

The dam was designed as a homogeneous earth embankment and constructed with soils generally ranging from SC to SM in Unified Classification. The stability is assessed assuming a homogeneous dam. The dam is subjected to rapid drawdown because the approximate reservoir drawdown rate of 11 ft per day exceeds the critical rate of 0.5 ft per day for earth dams. According to guidelines presented in Design of Small Dams, U. S. Department of the Interior, Bureau of Reclamation for small homogeneous dams, with stable foundation, subjected to a drawdown and with embankment composed of SC to SM materials, the recommended slopes are 3H:1V upstream and 2H:1V downstream. The recommended crest width is 17.2 ft. Based upon these general guidelines the embankment crest and downstream slope are adequate, but the 2.5H:1V upstream slope is slightly steeper than the that recommended.

6.2.4 Seismic Stability: The dam is located in Seismic Zone 2. Therefore, according to the Recommended Guidelines for Safety Inspection of Dams, the dam is considered to have no hazard from earthquakes provided static stability conditions are satisfactory and conventional safety margins exist.

6.3 Evaluation: An accurate check on the stability of this structure cannot be made since there was no stability analysis and laboratory test data available. The embankment crest width and downstream embankment slope slightly exceed the requirements recommended by the U. S. Bureau of Reclamation; however, the upstream slope is slightly steeper than recommended when subject to rapid drawdown. The existing upstream slope is 2.5H:1V while a 3H:1V slope is recommended for SC to SM materials subjected to the rapid drawdown condition.

Since the structure was designed in accordance with SCS standards, properly constructed and has a good performance record, the slightly steeper slope is not considered a serious problem and therefore, no additional studies are recommended.

Overtopping is not considered a problem because of the small depth and duration of flood. Also the velocity of 4.9 fps is less than the effective eroding velocity for a vegetated earth embankment, assumed as 6 fps. Some erosion is anticipated on the downstream slope during overtopping; however, tailwater conditions will absorb the additional flow. Since no undue settlement, cracking, or seepage was noted at the time of inspection, it appears that the embankment is adequate for control storage at elevation 160 msl.

The seepage observed below the discharge pipe is believed to represent seepage through the dam but it could possibly be related to spring activity. This does not necessarily create an unsafe condition; however, the seepage should be monitored periodically in attempt to detect any significant increases in flow which may result in piping within the embankment. If increased flows should occur, a Professional Engineer with expertise in Geotechnical Engineering should be contacted to evaluate the problem and make recommendations for required corrective measures.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment: Sufficient engineering data is available for assessing the dam except for stability. The visual inspection revealed no findings that proved the dam to be unsound. A routine maintenance program does not exist. Also, there is no emergency operation and warning plan. Overall, the dam was in good condition at the time of inspection. U. S. Army, Corps of Engineers Guidelines indicate the appropriate Spillway Design Flood (SDF) for this dam is the ½ PMF. The spillway will pass 30 percent of the PMF (60 percent of the SDF) without overtopping the crest of the dam. Flows overtopping the dam at a maximum velocity of 4.9 fps during the SDF are not considered detrimental to the embankment with respect to erosion. The spillway is judged inadequate, but not seriously inadequate. Also, a stability check is not required.

7.2 Recommended Remedial Measures:

7.2.1 Emergency Operation and Warning Plan: It is recommended that a formal emergency procedure be prepared, prominently displayed, and furnished to all operating personnel. This should include:

1) How to operate the dam during an emergency.
2) Who to notify, including public officials, in case evacuation from the downstream is necessary.

7.3 Required Maintenance: It is recommended that a regular maintenance operation program be established and documented for future reference. Also, the inspection revealed the following maintenance items that should be scheduled by the owner during a regular maintenance period within the next 12 months:

a) The grass and weeds on the dam embankment and in the emergency spillways should be cut at least once a year and preferably twice a year. Maintenance is recommended in the early summer and fall.

b) Existing trees on the dam should be cut to the ground.

c) The upstream slope should be protected against further erosion by lining with riprap.

d) The plunge pool area should be protected against further erosion by lining with riprap or utilizing some other effective measure.

e) Seepage present below the discharge pipe should be monitored quarterly to detect any increase in flow rates which may cause piping within the embankment. If increased flows should occur, a Professional Engineer with expertise in Geotechnical Engineering should be contacted to evaluate the problem and make recommendations for required corrective measures.

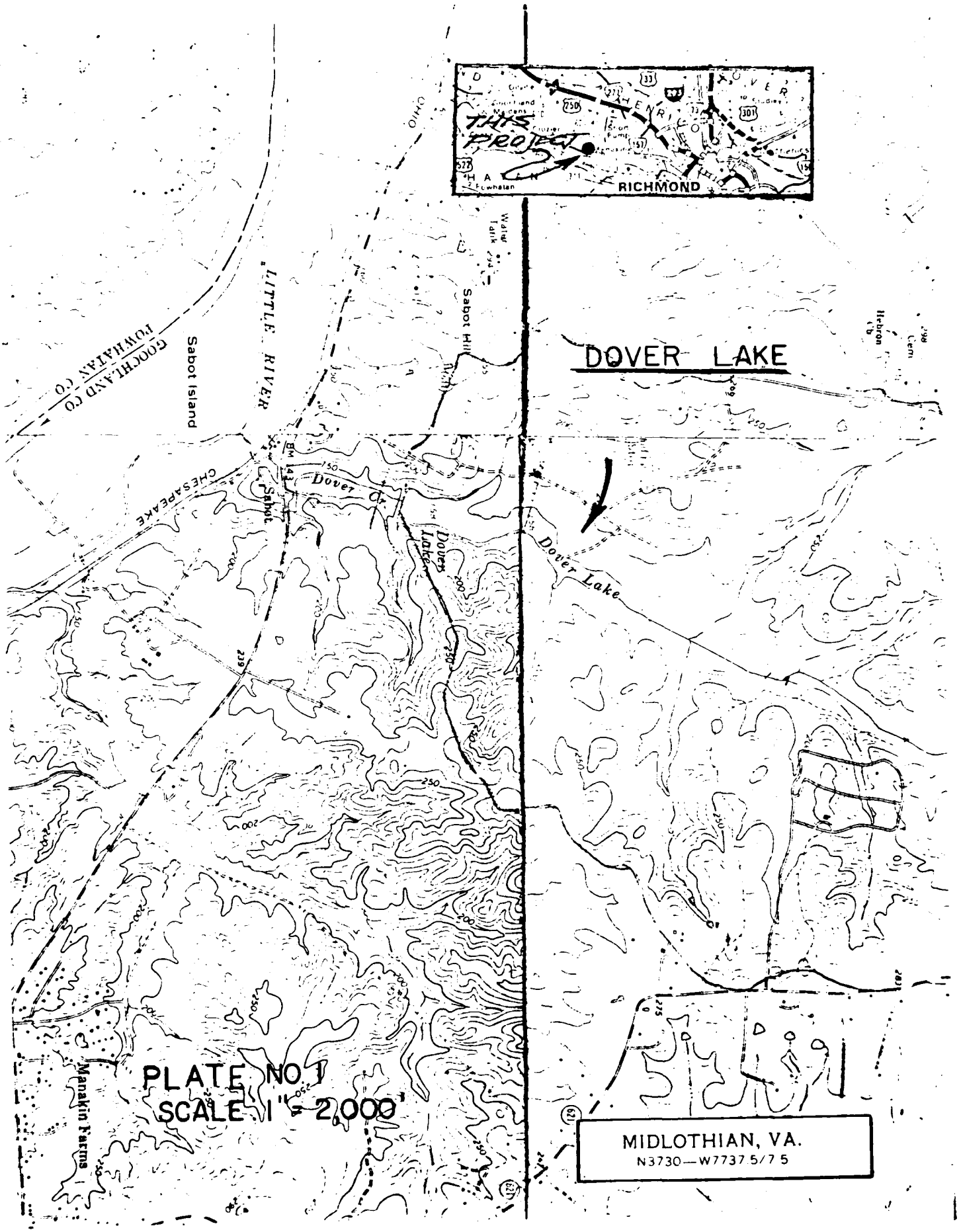
f) The eroded area observed in the discharge section of the emergency spillway should be backfilled and reseeded.

g) Animal burrows in the embankment should be backfilled

h) A staff gage should be installed to monitor water levels.

APPENDIX I

MAPS AND DRAWINGS


THIS PROJECT
RICHMOND
DOVER LAKE
LITTLE RIVER
Sabot Island
Sabot Hill
Dover Ck.
Dover Lake
Dover Lakes
CHESAPEAKE
GOOCHLAND CO
POWHATAN CO
Manakin Farms
PLATE NO 1
SCALE 1" = 2,000'
MIDLOTHIAN, VA.
N3730—W7737.5/7.5

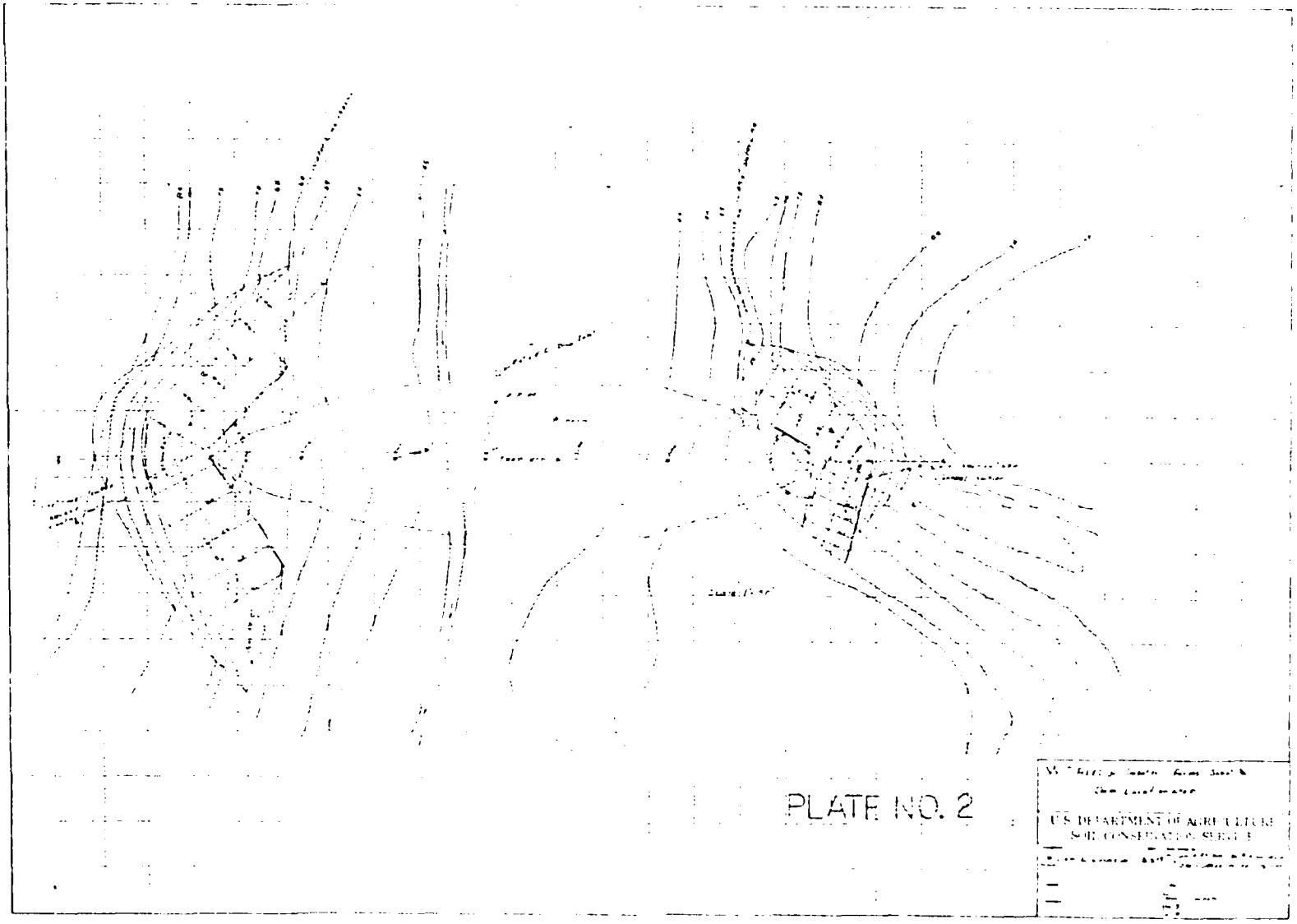
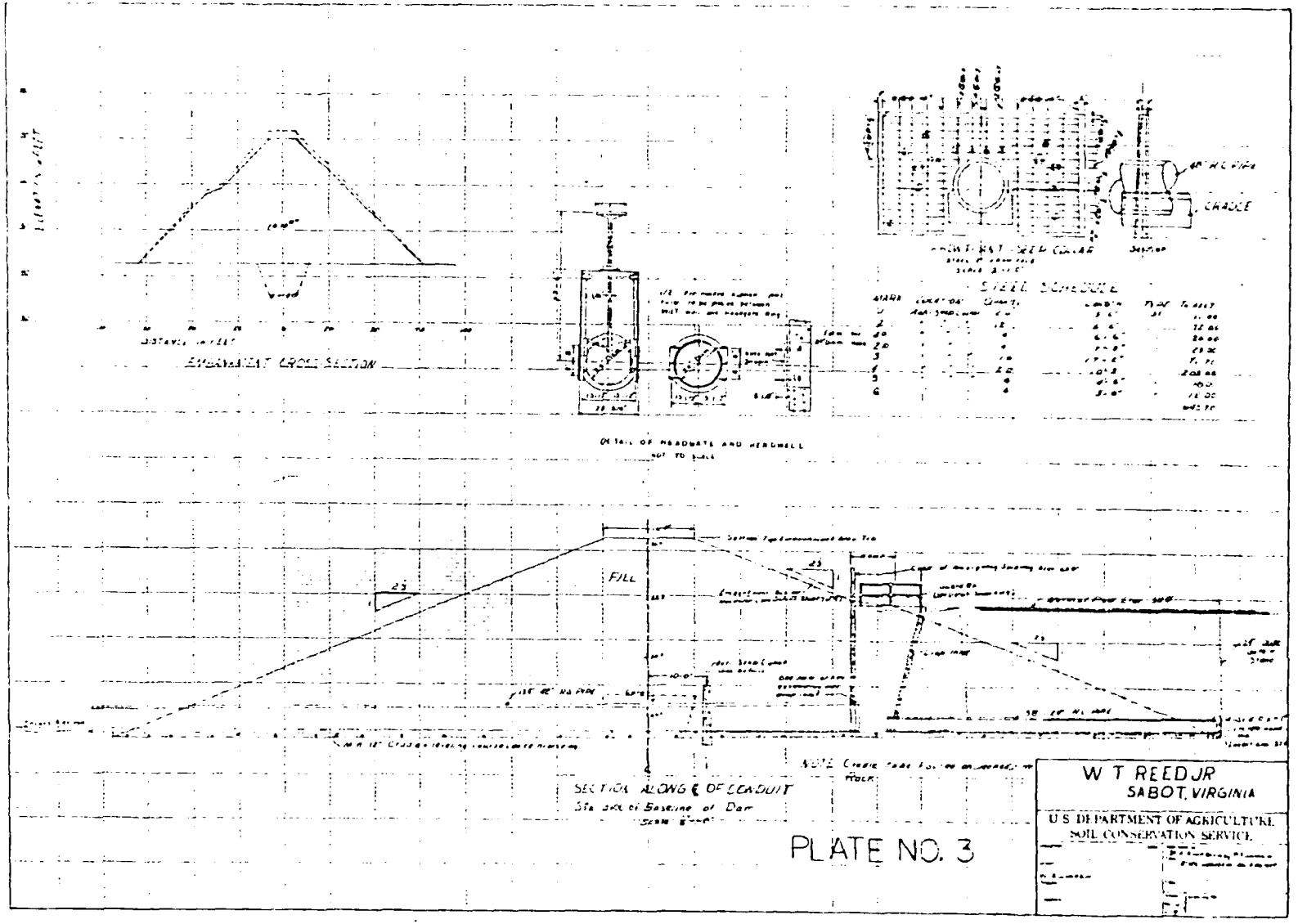
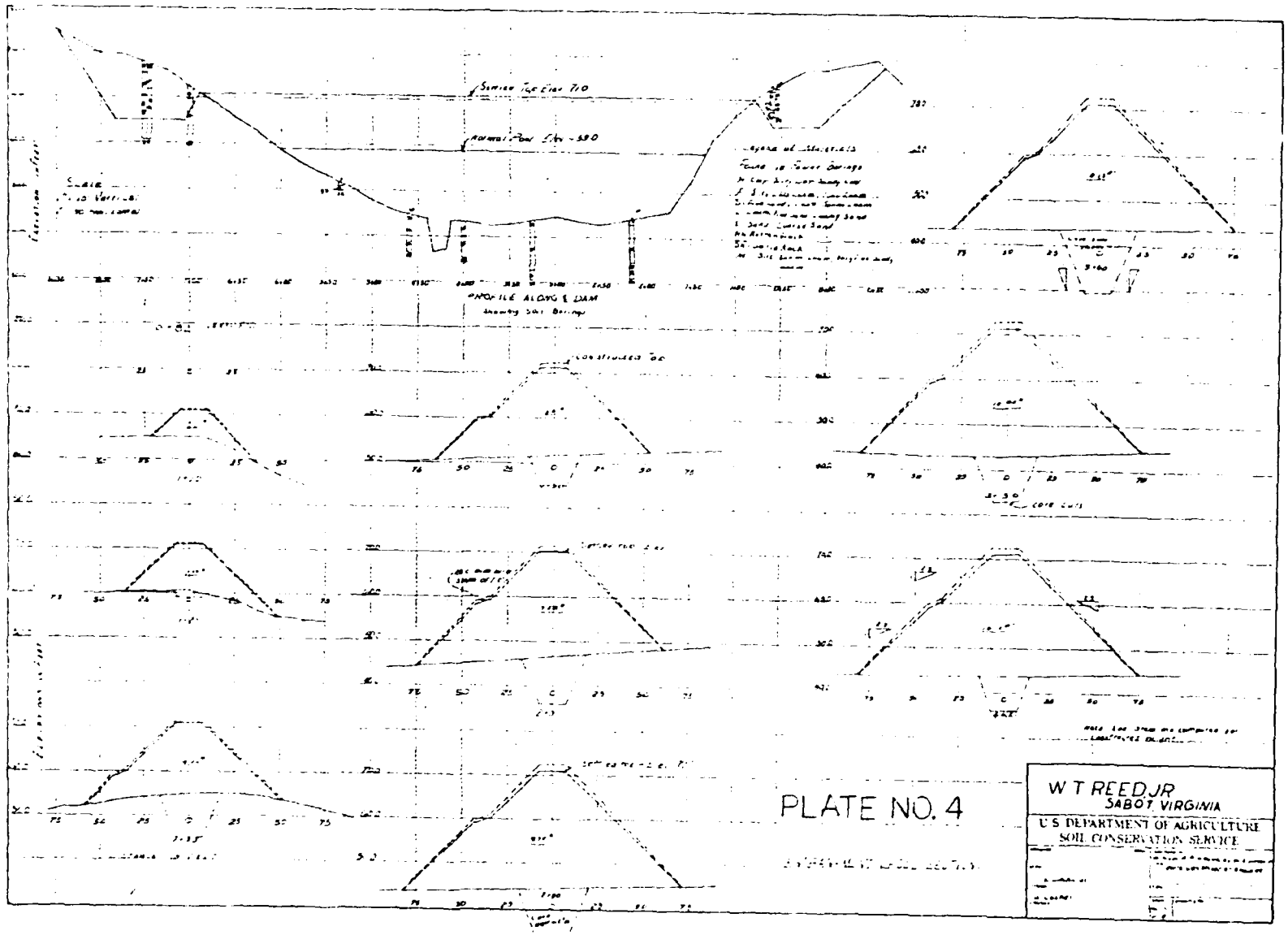


PLATE NO. 2
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE


EMBANKMENT CROSS SECTION
DETAIL OF HEADGATE AND WELLWELL
NOT TO SCALE
FILL
SECTION ALONG ℄ OF CONDUIT
Sta 3+00 of Baseline of Dam
W T REED JR
SABOT, VIRGINIA
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
PLATE NO. 3


PROFILE ALONG E DAM
PLATE NO. 4
W T REEDJR
SABOT, VIRGINIA
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

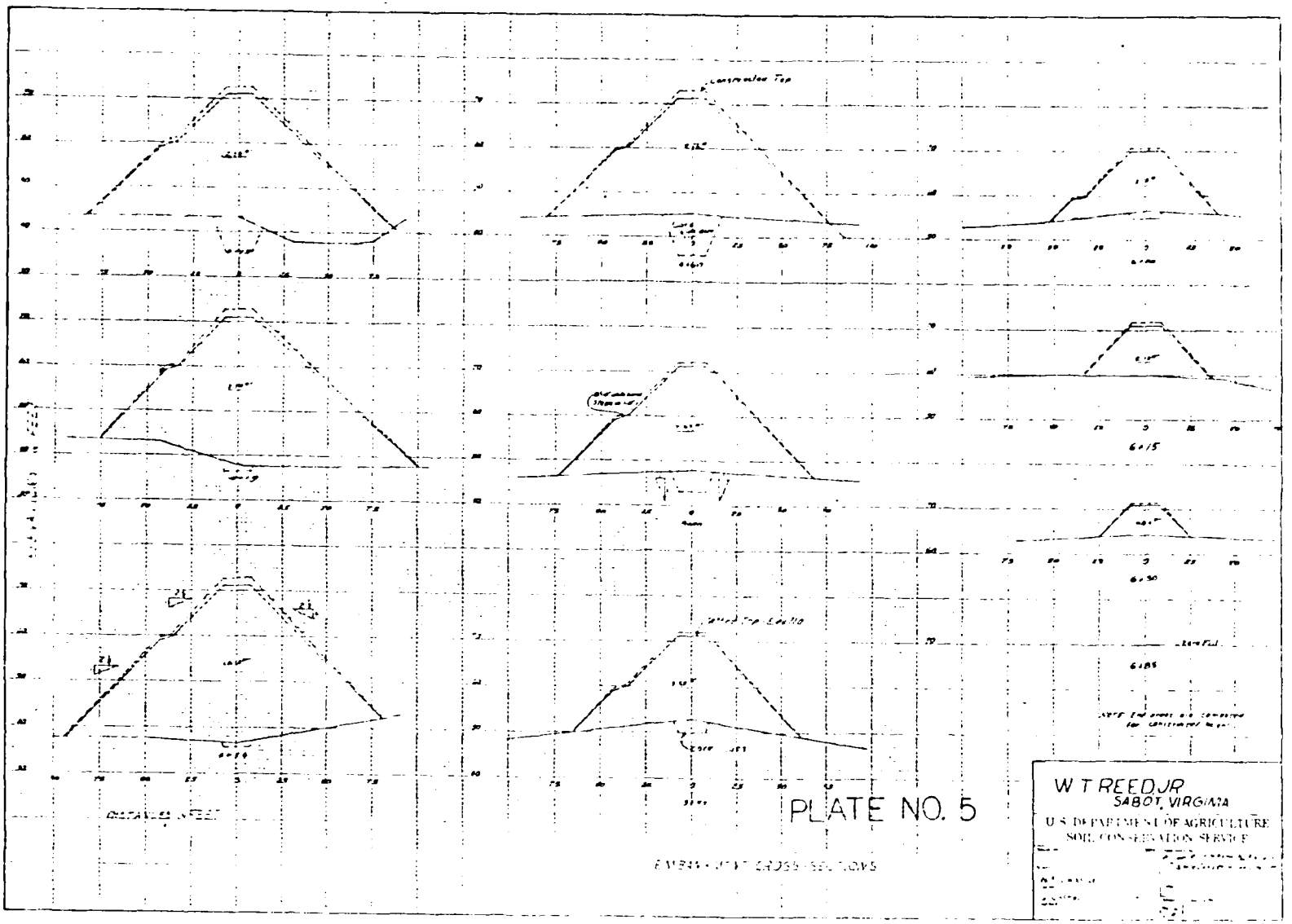


PLATE NO. 5

W T REED JR
SABOT, VIRGINIA

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

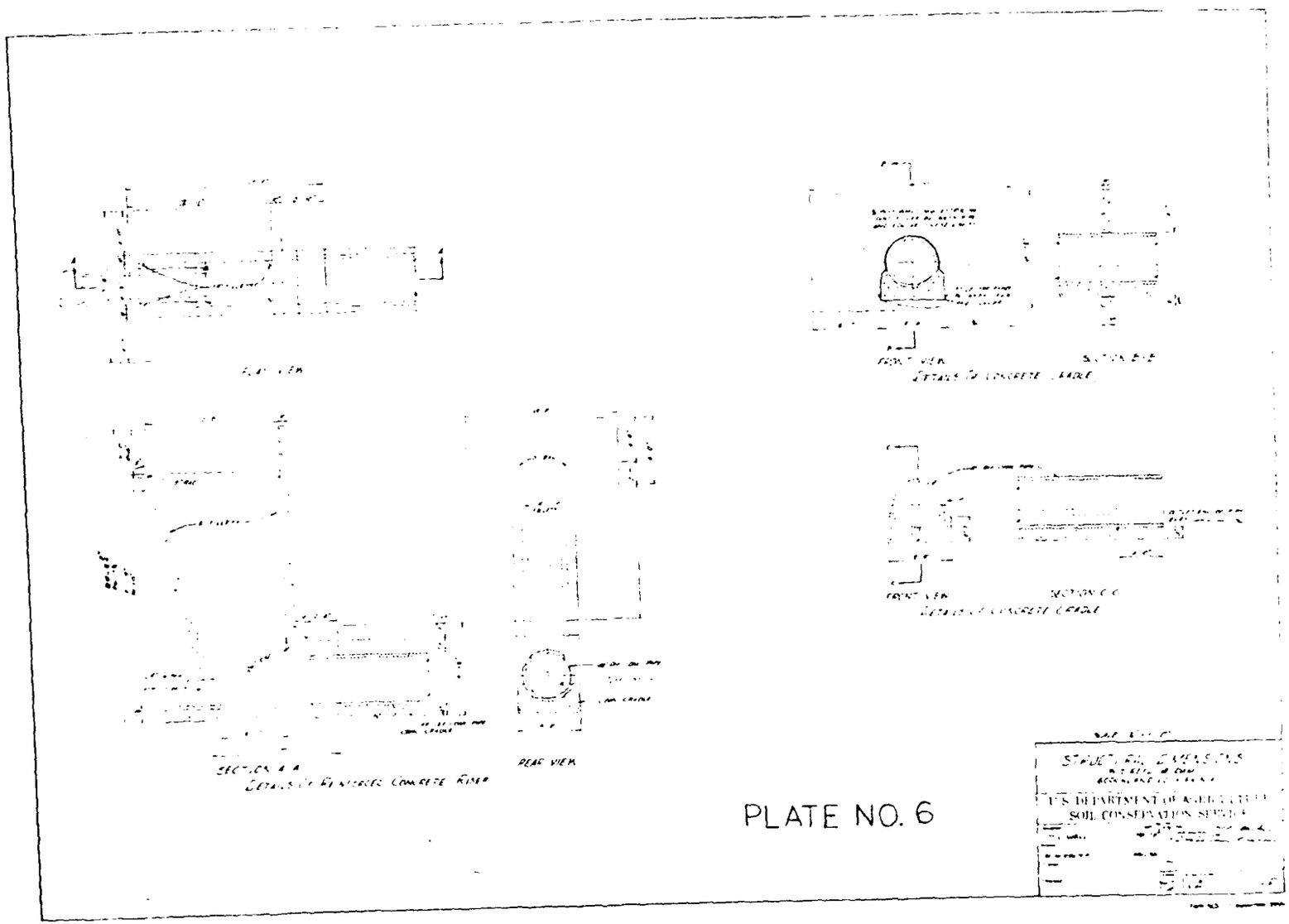


PLATE NO. 6

APPENDIX II

PHOTOGRAPHS

Photograph No. 1 - Upstream Face of Dam
(Arrow Indicates Intake Pipes)

Photograph No. 2 - Downstream Face of Dam

Photograph No. 3 - Emergency Spillway
at Left Abutment

Photograph No. 4 - Emergency Spillway
at Right Abutment

Photograph No. 5 - Outlet Pipe
and Plunge Pool

APPENDIX III

FIELD OBSERVATIONS

Check List
Visual Inspection
Phase I

Name Dam Dover Dam County Goochland State Virginia Coordinates Lat 37°-37.0' Long 77°-44.8'

Date(s) Inspection April 21, 1981 Weather Fair Temperature 55°F

Pool Elevation at Time of Inspection 160.0 msl Tailwater at Time of Inspection 135.3 msl

Inspection Personnel:

Schnabel Engineering Associates, P.C.
Raymond A. DeStephen, P.E.*
Gilbert T. Seese
Stephen G. Werner

J. K. Timmons & Associates, Inc.
Robert G. Roop, P.E.
Steve Oddi

State Water Control Board
Leon Musselwhite

U. S. Soil Conservation Service
Joseph Scales

Owner
Fredrick S. Reed,
Sabot Hill Farms, Inc.

Gilbert T. Seese, Recorder

* Not present during this inspection but visited site on June 9, 1981.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	The slopes, crest and abutment contacts were inspected and no cracks were noted. The embankment slopes were heavily vegetated with honeysuckle and briars making observation difficult. Ground conditions were damp at the time of the inspection.	The vegetation should be controlled.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	No unusual movements were noted on the dam or beyond the downstream toe.	-
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	No sloughing or erosion was observed on the downstream slope. Along the upstream slope numerous erosional notches occur at water level. These notches are cut a maximum of 3 ft into the embankment, 1 to 10 ft wide and occur along the entire length of the upstream embankment. The notches occur between stands of ½" to 2" diameter trees which also occur along the entire upstream slope along the water line. Several groundhog holes were observed along the bottom 10 ft of the downstream slope, approximately 90 ft from the left abutment. Both embankment slopes are 2.5H:1V. The 8 ft wide berm shown on the design drawings on the upstream slope was submerged.	The trees should be removed and riprap placed to control erosion by wave action. Attempts should be made to prevent groundhog burrowing.
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	The vertical and horizontal alignment of the dam appeared to be good.	-
RIPRAP FAILURES	The only riprap observed was hand placed riprap around principal spillway discharge pipe. This riprap appeared to be in good condition.	-

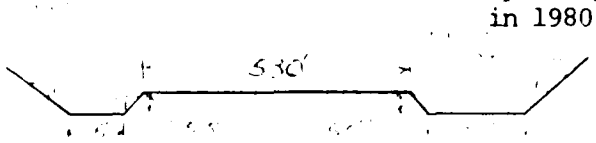
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
FOUNDATION	Both ends of the embankment tie into the abutments at emergency spillways. The abutments consist of residual soils ranging from silty sands (SM), fine sandy silts (MH) to silty clays (CL). The abutments are grass covered in cut areas with trees and natural vegetation in other areas.	-
ANY NOTICEABLE SEEPAGE	Seepage was observed in areas around the discharge pipe. See field sketch. Toe of downstream slope was dry.	Seepage should be monitored.
DRAINS	None Observed	-
MATERIALS	Embankment materials appear to be primarily silty sands (SM) to clayey sands (SC) with gravel, mica and fine sandy, clayey silt (MH) to silty clays (CL)	Mr. Scales said the entire embankment was constructed with clay.
VEGETATION	The embankment is heavily vegetated on both sides with honeysuckle and briars. Scattered small trees ranging from ½" to 2"± in diameter are also present, particularly along the upstream slope at pool level.	The vegetation should be controlled.

PRINCIPAL SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONTROL SECTIONS	None Observed	—
APPROACH CHANNEL	48" Reinforced concrete riser pipe intake structure.	No signs of deterioration, functioning properly.
DISCHARGE CHANNEL	48" Reinforced concrete pipe discharge structure (see Field Sketch, Sheet 2) No riprap in Plunge pool	No signs of deterioration, functioning properly. Riprap should be installed in plunge pool.
BRIDGE AND PIERS	None	-
EMERGENCY GATE	24" Slide gate valve	Mr. Reed said they do not use gate valve. Valve should be cycled.
GATES AND OPERATION	None Observed.	-

EMERGENCY SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONTROL SECTIONS	Two emergency spillway overflow sections. One in right, west abutment is 75ft wide and the one in the left, east abutment is 36 ft wide. Side slopes are approximately 2H:1V on both sides. 	Spillways were widened in 1980 to conform to plan.
APPROACH CHANNEL	The approach channels were in good condition. They were grass covered with mild slopes of 1 to 2%.	
DISCHARGE CHANNEL	The left discharge channel was in good condition while some erosion was noted in the right discharge channel. Both were grass covered with moderate slopes of 5%±	See "Miscellaneous" comments below.
BRIDGE AND PIERS	None	-
MISCELLANEOUS	Right emergency spillway was enlarged in 1980. Some erosion or washing was noted in the discharge section with the flow path 1 to 2 ft deep and 1 ft wide. The left side of the spillway is in fill, the right side in cut. Some erosion also noted along right side slope.	Eroded areas should be corrected and reseeded.
	Left emergency spillway was enlarged in 1980. The entire channel appears to be in cut and includes scattered exposures of highly weathered granite gneiss.	-

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATION
MONUMENTATION/SURVEYS	None Observed	-
OBSERVATION WELLS	None Observed	-
WEIRS	None Observed	-
PIEZOMETERS	None Observed	-
STAFFGAGES	None Observed	A staffgage should be installed to monitor water levels.
OTHER	High water mark on cabin @ El 167.8 7.8 ft above pool elevation	-

VISUAL EXAMINATION	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
SLOPES	Slopes around reservoir vary from approximately 5H:1V to 3H:1V. They are mostly wooded with some grassed areas on the flatter slopes. A cottage has been built on a point on the right side of the reservoir. Slopes in this area are less than 5H:1V. The shore line appears stable and was free of debris.	-
SEDIMENTATION	Sedimentation present in upper section of lake. A 2 to 3 ft change in water depth has been noticed in recent years.	Sedimentation was reported by the owner, Mr. Reed at the time of the inspection.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Primary channel is approximately 8 ft wide and 2 ft deep. N = 0.1, dense vegetative cover. The left side of the flood plain is a cultivated field and the right side is heavily wooded. The downstream channel is located in a valley with steep side slopes of 10H:1V to 20H:1V.	-
SLOPES	Channel slopes below dam are approximately; 10% on the right side and 5% on the left side	-
APPROXIMATE NO. OF HOMES AND POPULATION	One home, owned by Mr. Fred Reed is 1/4± mile downstream. Basement of house is approximately 12 ft above the stream.	Potential for flooding exists due to downstream restrictions.

CHECK LIST

ENGINEERING DATA

DESIGN, CONSTRUCTION, OPERATION

ITEM		REMARKS
REGIONAL VICINITY MAP	Midlothian, Virginia USGS 7½ minute Quadrangle	—
DESIGN/CONSTRUCTION HISTORY	Constructed by Moore, Reddish & Kelly and completed in 1958. Both emergency spillways were constructed smaller than designed. Consequently, the spillways ran full once a year± and considerable erosion occurred. Both spillways were enlarged to design size in 1980.	—
PLAN OF DAM	SCS, see Appendix I	—
TYPICAL SECTIONS OF DAM	SCS, see Appendix I	—
OUTLETS - PLAN DETAILS CONSTRAINTS DISCHARGE RATINGS	SCS, see Appendix I	Inlet constructed different from plans
SPILLWAY- PLAN SECTION DETAILS	SCS, see Appendix I	Original emergency spillways not constructed to plan
OPERATING EQUIPMENT - PLAN DETAILS	SCS, see Appendix I	—

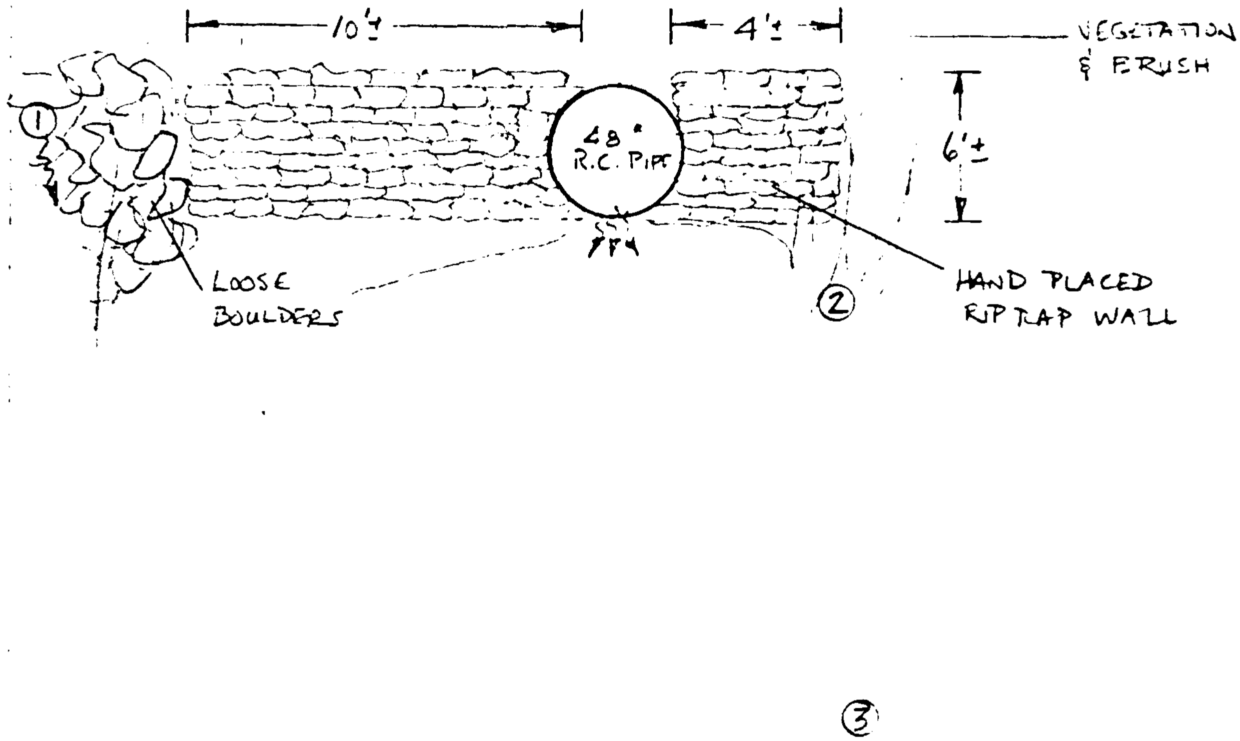
ITEM	REMARKS	
MONITORING SYSTEMS	None. Cottage on point in right upstream reservoir area has been used to monitor water levels.	-
RAINFALL/RESERVOIR HIGHPOOL RECORDS	None	Information obtained from conversation with owner during inspection.
GEOLOGY REPORTS	Geology of the Hylas and Midlothian Quadrangles, Virginia	-
BORROW SOURCES	Reservoir, emergency spillways and hilltop on right side of the dam	-
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY-FIELD TEST DATA	SCS, Appendix I	-
HYDROLOGIC/HYDRAULIC DATA	SCS, Appendix I	-

ITEM	REMARKS
DESIGN REPORTS	No formal report prepared, but SCS has design data on file at the Goochland County office.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Design computations available at SCS office for hydrology and hydraulics. No stability studies performed.
POST CONSTRUCTION ENGINEERING STUDIES RECORDS, SURVEYS	No scheduled or routine inspections are made however SCS does visit the structure intermittently.
MODIFICATIONS	The emergency spillways as constructed were smaller than recommended in design. Both spillways were increased to design capacity in 1980.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Extensive erosion of emergency spillways occurred during the October 1979 storm. Water was at a depth of 4 ft^{+} in the emergency spillways. No formal reports
MAINTENANCE OPERATION RECORDS	None available

OF DAM

DAM
SHEET 1
DATE 4-21-81

DOWNSTREAM SLOPE

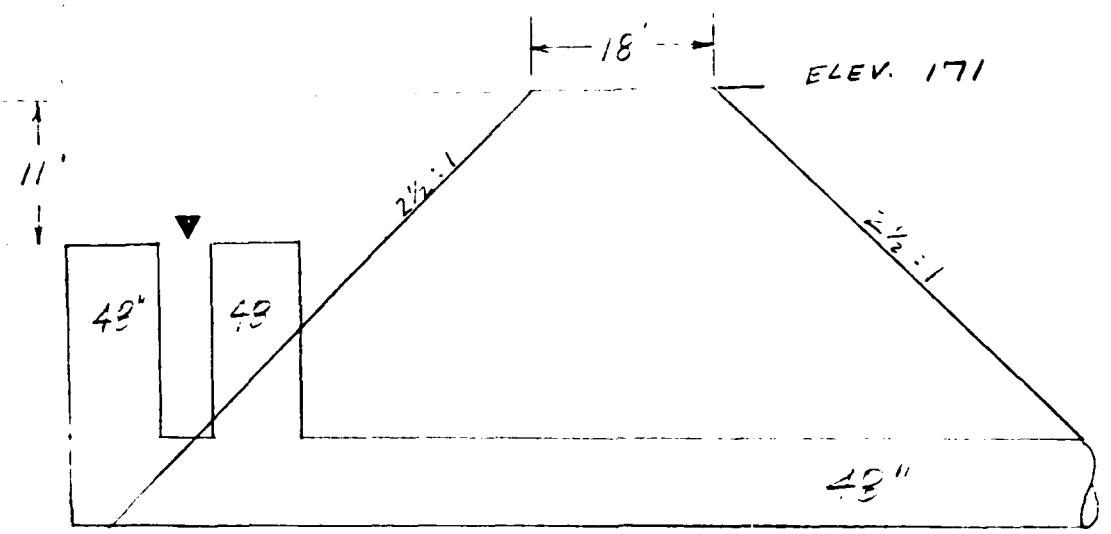


NO SCALE

① IRON STAINED SEEPAGE FLOWING @ ESTIMATED 2-3 gpm FROM BASE OF ROCK, ABOUT SAME ELEVATION AS TOP OF DISCHARGE PIPE. LOCATED 12-14' FROM RIGHT END OF WALL. NO TURBIDITY WAS NOTED.

② IRON STAINED SATURATED AREA LOCATED 5'± BEYOND DISCHARGE PIPE; NO FLOW OBSERVED.

③ IRON STAINED SATURATED AREA LOCATED 50'± BEYOND DISCHARGE PIPE; NO FLOW OBSERVED.



FIELD SKETCH

PRINCIPAL SPILLWAY

SHEET 2

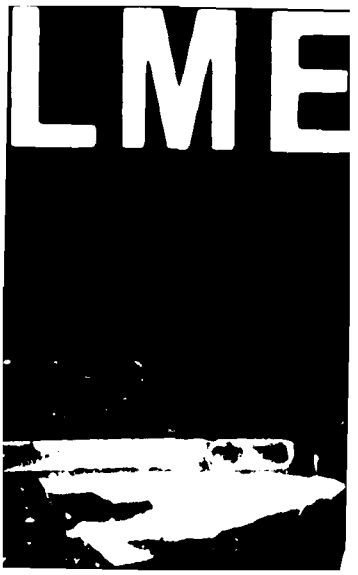
NO SCALE

DOVER LAKE

21 APRIL 1981

APPENDIX IV - REFERENCES

1. Recommended Guidelines for Safety Inspection of Dams, Department of Army, Office of the Chief of Engineers, 46 pp.
2. Design of Small Dams, U. S. Department of Interior, Bureau of Reclamation, 1974, 816 pp.
3. Soil Survey of Goochland County, Virginia, 1980; USDA, SCS and VPI & SU, 137 pp.
4. Geology of the Hylas and Midlothian Quadrangles, Virginia by Bruce K. Goodwin, Virginia Division of Mineral Resources, Reports of Investigations 23, 51 pp.
5. HEC-1 Dam Breck Version, Flood Hydrograph Package, Users Manual for Dam Safety Investigations, the Hydrologic Engineering Center, U. S. Army Corps of Engineers, September, 1978.
6. Hydrometerological Report No. 33, U. S. Department of Commerce, Weather Bureau, U. S. Department of Army, Corps of Engineers, Washington, D. C., April, 1956.
7. Technical Paper No. 40, U. S. Department of Commerce, Weather Bureau, Washington, D. C., May, 1961.


LME